Nuclear INFORMATION

Greater St. Louis Citizens' COMMITTEE FOR NUCLEAR INFORMATION

ST. LOUIS, MISSOURI MAY-JUNE, 1959

FALLOUT ... A FORECAST FOR ST. LOUIS

Based on New Fallout Facts from Recent Congressional Hearings

A great deal of new information about the fallout problem has just become available. On May 4 – 8 in Washington a subcommittee of the Joint Congressional Committee on Atomic Energy, under the chairmanship of Rep. Chet Holifield of California met to hear testimony on the present state of knowledge about fallout. CNI has received copies of nearly all of the material submitted for the hearing record,* and in this issue presents conclusions from a study of the record with a view to estimating the degree of fallout hazard in St. Louis.

The new information allows us to answer this question with reasonable accuracy: How much radiation will be received by people living in St. Louis from the fallout produced by past nuclear explosions, on the supposition that no more explosions occur? The new hearings do not, however, provide a clear-cut answer to the next question: How much harm will be caused by the expected burden of fallout radiation?

To find out how much fallout radiation will be received by people in St. Louis, we can use two main sources of information. (1) An AEC-supported research laboratory at Columbia University, under the direction of Dr. J. L. Kulp, has studied the strontium 90 (Sr 90) content of bones taken from hundreds of people all over the world. These results, through 1957 and part of 1958, were reported to the hearings in testimony by a member of the laboratory, Dr. A.R. Schulert. Although the Columbia laboratory has not studied bones from St. Louis individuals, it is possible to use their analyses of bones from New York and elsewhere, together with other pertinent data to calculate expected Sr 90 levels for people in St. Louis. (See page 3, right column) (2) Another approach (see page 3, left column) is to use new data – the total amounts of fallout produced to date, the amount of fallout from past tests that will come to earth in future years, the amounts of Sr 90 in the diet, and related factors – to calculate how much Sr 90 will be absorbed by St. Louisans.

These calculations lead to conclusions on two basic points:

• **Sr 90 in the diet.** In the absence of further testing, the Sr 90 content of the average St. Louis diet will rise from its 1958 level of about 19 units to a maximum of about 50 Strontium units (S.U.) in 1965. After that it will decline slowly, so that in the year 2000 the Sr 90 level in our diet will come down to match the 1958 level of 19. (See Fig. 1, page 2)

• **Sr 90 in the bone.** Calculations from the St. Louis diet show that a child born in 1958, living in St. Louis until maturity at age 25 will have in his bones an estimated 11 S.U. in 1983. His average value over the period 1958-1983 will be 15 S.U. The heaviest Sr 90 burden will be carried by children born in the peak year of 1965. These children in their first year of life will absorb an estimated 18 S.U. into their bones. Calculations based on Sr 90 analyses of bones (outside of St. Louis) give about 11 S.U. for this value.

How significant is the radiation resulting from these expected amounts of Sr 90? Two useful comparisons can be made. First, we can compare the Sr 90 content of the St. Louis diet with the maximum permissible concentration (MPC) of Sr 90 recommended for the general population by the International Committee on Radiological Protection, which sets standards in these matters. Second, we can compare the radiation from Sr 90 in the bones with the amount of radiation that we normally receive from cosmic rays, radioactive rocks, and other unavoidable natural sources of radioactivity. These figures are shown in the following table:

1965 Strontium 90 levels in St. Louis diet and bone

Avg. Sr 90 in St. Louis diet, 1965	53 S.U.[1]
Maximum Permissible Concentration of Sr 90 in diet, "old"	80 S.U.[2]
Maximum Permissible Concentration of Sr 90 in diet, "new"	33 S.U.[3]
Avg. Sr 90 in bone, 1 year old child, St. Louis, 1965	14.5 S.U.[4]
Radiation from Sr 90, 1 year old child, St. Louis, 1965	
to bone, avg.	36 millirem/year[5]
to bone, "hot spots"	90 millirem/year[6]
to bone marrow, avg.	7-29 millirem/year[5]
to bone marrow, "hot spots"	36-145 millirem/year[5]
Radiation from natural sources	
to bone	130 millirem/year[7]
to bone marrow	95 millirem/year[7]

[1]Calculated according to Fig. 1, this bulletin.

[2]Recommended by 1953 Report of International Commission on Radiological Protection.

[3]Recommended by 1958 Report of International Commission on Radiological Protection.

[4]Average of two calculations; 18 S.U., from data of Fig. 1 and 11 S.U. from calculation described on page 3, this bulletin.

[5]Calculated from average of 14.5 S.U. in bone and factors given in Report of U.N. Scientific Committee on Atomic Radiation, New York, 1958, page 107, 108.

[6]Based on variations in Sr 90 content of different bone reported to hearings.

[7]From Report of U.N. Committee, page 9.

From this table we see that the St. Louis diet will either exceed the new Sr 90 maximum permissible concentration by about 50%, or reach about 60% of the old MPC, depending on which value is used as a standard. The old MPC of 80 S.U. was recommended by the International Committee on Radiological Protection in 1953 and is now in wide use. The new MPC of 33 S.U. was recommended in 1958. The question of which MPC ought to be used

A FORECAST FOR ST. LOUIS *(continued from p. 1)*

now was not considered by the hearings, but thus far national practice has always followed the international recommendation. Figure 1 (p. 2) shows that we can expect the St. Louis diet to reach the new permissible value in about 2 years from now.

The above table also shows that, in general, fallout Sr 90 will at the maximum period give the average St. Louis year old child an amount of extra radiation to areas of his bone marrow that is near the amount he already gets from natural sources. As explained on page 5 of this bulletin, natural radiation is evenly spread in the bone, while Sr 90 radiation tends to become concentrated in "hot spots." In other words, this comparison shows that, at the time of its maximum, the addition of fallout radiation will just about double the radiation received by certain areas of the bone and bone marrow from natural sources.

Variations from the average. These considerations thus far refer only to averages in the population. Analyses that were reported to the hearings of Sr 90 in bones show that there is a wide range of variability among individuals. Accordingly, we can expect about 10% of the population to reach Sr 90 bone levels that are twice the St. Louis average given in the above table; about 1% of the population will reach 5 times the average level.

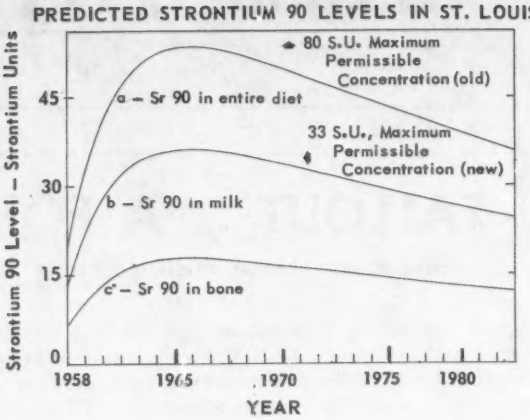
Will it be harmful? This brings us to the most difficult question: What harm may result from a diet which exceeds the new MPC of 33 units, and which doubles the natural level of radiation? Here, the hearings leave us in doubt. One witness Dr. Jack Schubert, concluded (see p. 6) that as little as 20 millirem (the millirem is a measure of radiation dose) of radiation received by a fetus would increase the rate of childhood cancer by 1%. According to the results shown in the table above, on the average St. Louis children born in 1965 may well receive, before birth, a radiation dose in the range of 20 millirem. If Dr. Schubert is right, fallout from tests already completed might be expected in future years to cause an increase of about 1% in the amount of childhood cancer in areas such as St. Louis. But Dr. Schubert's prediction was challenged by another witness at the hearings, Dr. Austin Brues, and the Committee did not attempt to resolve this disagreement.

Other fallout hazards. In the foregoing estimates, only the hazard from Sr 90 is considered. But the hearings reported (see p. 6) that radiation from other fallout materials – especially strontium 89, cesium 137, and iodine 131 – adds to the hazard. Since these elements are rather short-lived, their effects are important only during a period of nuclear explosion and in the following year or so. For this reason this type of fallout radioactivity has not entered into our calculations of the hazard in the next 25 years. However if nuclear explosions are resumed, the short-lived fallout radiation will for a time *double* the radiation received from Sr 90 alone (see p.6). The hazard to a fetus that is developing during a period of nuclear explosions is due more to Sr 89 than to Sr 90 (see p. 6).

It will be noted that the conclusions reached in this issue of *N. I.* are not in complete agreement with conclusions expressed by some witnesses at the recent hearings and others who have discussed the fallout hazard. For example, one witness (see p. 5) stated that when it reached a maximum, fallout radiation would cause only a 5% increase over radiation to bone marrow from natural sources.

FIGURE 1

PREDICTED STRONTIUM 90 LEVELS IN ST. LOUIS



Similarly, a report in the Washington *Star* (May 11, 1959), at the end of the hearing states, "Mr. Holifield believes that all the necessary answers are now in on most fallout problems . . . Radiation from fallout, he pointed out, is roughly 10 per cent of the natural background radiation that has always existed."

Why CNI differs. There are several reasons why some CNI conclusions differ from the foregoing:

(a) Discussion at the hearings was in terms of "average" fallout figures; there was no evaluation of local high concentrations of fallout in various parts of the country. It is now known, however, that areas like St. Louis are receiving 2-3 times more fallout than average places (so that the radiation levels are that much higher than average in St. Louis).

(b) Some of the calculations by witnesses on fallout radiation in the bones appear to disregard important facts about the problem, which need to be considered in making proper calculations (see p. 5). In particular, the discussion at the hearings failed to take into account the tendency of Sr 90 to concentrate in "hot spots" in the bone, thereby exposing some bone and marrow cells to amounts of radiation considerably in excess of the average. One detailed study of this problem♦ which concludes that localization makes Sr 90 about 20 times more hazardous than it appears from averages seems not to have been mentioned at the hearings. Localization also has an important effect on comparisons of fallout radiation with radiation from natural sources, but such comparisons were reported to the hearings (see p. 5) without considering the problem of localization.

(c) The possibility of increased incidence of cancer from expected levels of fallout was not fully examined by the hearings, so that we cannot reach a firm conclusion as to whether or not this hazard will materialize.

Sr-90 intake can be reduced. Finally it should be noted that the Congressional hearings also heard reports of new information which suggests possible ways of reducing the Sr 90 level of the diet. This matter will be discussed in the next issue of *Nuclear Information*. S.C., J.M.F., T.A.P., E.R., J.B.R.

*) The complete record of the hearings will be available from the Joint Congressional Committee on Atomic Energy in printed form in a few months.

♦A. Engtrom et al "Bone and Radiostrontium", New York, John Wiley and Son, 1957.

FALLOUT EFFECTS . . . . By CNI Calculation

ENOUGH new information was released during the recent hearings to make a new calculation of expected bone levels of Strontium 90 (Sr 90) seem useful. To figure out how much Sr 90 St. Louisans will absorb from fallout, we need to know how much fallout material is now in our diet, how much is yet to come down to earth and enter the foods we eat in the future, and how dietary Sr 90 is absorbed by the body. As a result of very informative testimony presented to the hearings, we now have more precise values for these factors and can therefore make a reasonably accurate estimate of the amounts of Sr 90 that we expect to find in the bones of St. Louis residents now and in the future.

From figures given in the testimony of Mr. Merril Eisenbud of the New York office of the AEC, we know that past nuclear tests have produced a total of 6.9 megacuries of Sr 90, of which 2.6 megacuries have already reached the earth, while the remaining 4.3 megacuries are yet to come down. Detailed testimony by Dr. Conrad P. Straub of the U.S. Public Health Service reports how much of the Sr 90 now on the earth has already appeared in various kinds of food (see p. 6 col. 2) in the Cincinnati area. From these facts, and knowledge that half of the radioactive Sr 90 will disappear every 28 years, we can calculate how much Sr 90 will be present in the Cincinnati diet for the next 25 years. To convert these values into facts that pertain to St. Louis we need to know the relative Sr 90 levels of foods in St. Louis and Cincinnati. Fortunately the U.S. Public Health Service has been measuring Sr 90 in milk from both cities; in 1958 milk in Cincinnati averaged 8.5 Strontium units (S.U.) while St. Louis milk averaged 13.2 S.U. Dr. Straub reports that about 2/3 of the Sr 90 concentration of the diet is due to milk, so that we may use the two milk values to estimate the dietary situation in St. Louis.*

From all these considerations a curve can be drawn which shows the expected Sr 90 content of the St. Louis diet for the period 1958-1983. This is shown in **Fig. 1** curve (a). The milk levels are shown in curve (b).

This curve can now be used to calculate the amount of Sr 90 that will be absorbed in the bodies of people who eat a diet of the type described in Fig. 1. For this calculation we need to know what part of the dietary Sr 90 is absorbed and what part is rejected. Estimates reports to the hearings by Dr. Cyril Comar of Cornell University set this rejection rate (or "discrimination factor") at 1/2 – 3/4. If we assume an average rejection rate (midway between these extremes) of 2/3 and divide the diet curve in Fig. 1 by 3, we then have a new curve which describes the levels of Sr 90 that will be found in bone newly formed in various years between 1958 and 1983. This curve is shown in Fig. 1, curve (c).

According to curve (c), a child born in St. Louis in 1965 (the year in which Sr 90 from fallout due to tests up to the end of 1958 will be at its maximum), will contain in the bones formed in the first year of life an estimated 18 S.U.

To work out the Sr 90 level expected in the bones of children now growing up in St. Louis we must now consider the process of bone growth and how much new bone is produced from dietary materials in each year of a

(continued on p. 4)

FALLOUT EFFECTS . . . . From Kulp Bone Studies

THE INCREASING amounts of strontium 90 (Sr 90) in human bones have been followed by laboratory analysis since 1953, mostly at the AEC-supported Lamont Geological Observatory of Columbia University, New York, under the direction of Dr. J.L. Kulp. Dr. Kulp's latest findings, which were released at the recent hearings, provide one of the best means we now have of estimating how much Sr 90 from tests already completed will be absorbed by humans. This information is, of course, necessary in figuring out what hazard might arise from fallout.

The Lamont Laboratory has studied the bones of people who died during 1957-58. All contained some Sr 90, the largest amount being present in bones of one-year-old infants. The average amount in these infants from U.S. and Canada is 1.5 strontium units (S.U.). This age group is of particular interest because the first year of life is a time of great sensitivity to radiation. (Older children now show less Sr 90 in their bones simply because there was less or no fallout during their earlier years.)

The fallout levels in the St. Louis area are twice the national average. This fact has been clearly shown by studies of the Sr 90 levels in milk (see *Nuclear Information* February, 1959). Milk is the principal source of calcium for our children, and consequently it is the major source of Sr 90, which is very similar to calcium. Any change in the Sr 90 level in milk is therefore shortly followed by a proportional change in the Sr 90 level in the bones of growing children. So if we use Kulp's value of 1.5 S.U., in the bones of the average American infant in 1957-1958, we can expect the bones of the average year-old St. Louisan to have 2 x 1.5, or 3 S.U.

What will happen in the future? Only part of the fallout from past tests has reached the ground, and in the future years growing children will be exposed to higher concentrations of Sr 90. Therefore we have to know something about the amount of Sr 90 that has already been produced, but has not yet come down to earth. The Kulp group believes that in January 1959 the amount of Sr 90 still to come down was a little greater than the total amount that had already fallen out. From what is known about the rate of fallout, Kulp and his associates conclude that the amount of Sr 90 on the earth's surface will reach a maximum in 1966, when there will be 2.7 times as much of it as there is now. This is only true, of course, if there are no further fallout-producing nuclear explosions. After 1966 the amount will decrease slowly, returning to its 1959 level about the year 2000. Thus we might expect that the average Sr 90 level in the bones of year-old St. Louis babies in the late 1960's will be 2.7 x 3 S.U., or 8.1 S.U.

This estimate may however be too low, because Kulp's group used a rather low estimate of the amount of Sr 90 still in the stratosphere. At the same hearings, Mr. M. Eisenbud of the New York Operations Office of the AEC, who is in charge of a project devoted partly to the determinations of just such figures, estimated that the amount of Sr 90 still to come down is 4.3 megacuries, while Kulp estimates the future deposit at only 2.6 megacuries. If we use Eisenbud's figure in the calculations made in the preceding paragraph, we find that the Sr 90 burden of year-old St. Louisans in 1966 is likely to be 11 S.U. on the average.

(continued on p. 4)

Unsettled Questions

• Is there a safe or threshold amount of radiation?
THERE are two theories regarding the effects of a small amount of radiation on life. According to one theory any added amount of radiation will cause a proportional amount of damage; according to another theory there is a "threshold" dose of radiation below which the body can tolerate radiation without any harmful effects. Testimony by Dr. Karl Z. Morgan, Director, Health Physics Division, Oak Ridge National Laboratory, included the statement "For the present it is safe only to assume that types of radiation damage, such as gentic mutations, leukemic incidence, and shortenings of life spans, increase to some extent with any increase in dose taking place at any dose rate following any accumulated dose, viz. there is no threshold."

In contrast other witnesses (for example, Dr. Austin M. Brues of the Argonne National Laboratory and Dr. Lloyd W. Law of the National Cancer Institute) emphasized their opinion that a threshold does exist. The hearings did not bring out any explanation for this difference of opinion although it has an important effect on any estimate of the hazard resulting from fallout. For example, one witness, Dr. Charles L. Dunham, Director of the Division of Biology and Medicine of the AEC, pointed out that if the threshold theory is true fallout might cause no additional cases of leukemia and bone cancer, but if there is no threshold we may expect in the United States up to several hundred additional cancer cases per year for the next 70 years, if no further tests occur.

• The relative significance of fallout and natural differences in radiation due to altitude.

One witness before the hearings (Dr. Brues) emphasized that radiation from fallout is not as significant a cause of cancer as differences in natural radiation due to altitude (high altitudes receive more cosmic rays than lower altitudes). Dr. Brues stated, "For instance, the yearly natural radiation on the east coast is about 1/10 roentgen per year and in the larger cities in Colorado is about twice this – yet actually New York reports a higher rate of leukemias than Colorado."

Directly contradictory is Dr. Morgan's statement, "In order to determine with certainty the influence on man of exposures at the level of natural background radiation, observations will have to be made on many men that have been exposed at 2 or more levels, e.g., background and twice background, over many generations. Contrary to suggestions of a number of scientists and others the required information cannot be obtained satisfactorily by observing the biological effects of cosmic ray exposures at 2 or more elevations, e.g., Washington, D.C. and Denver, Colorado, because in this case there would be far too many uncontrolled variables; some of which would affect the well-being of man much more than his exposure to background radiation."

• Possibility of increased childhood cancer from fallout.

One witness, Dr. Jack Schubert, senior chemist of the Division of Biological and Medical Research at the Argonne National Laboratory, presented evidence based on recent studies by British physicians of the effects of X-irradiation on the fetus on the occurrence of cancer during childhood. The British report showed that delivery of about 2 roentgens to the human fetus causes a doubling in the frequency of childhood cancer and Dr. Schubert concluded that "present levels of fallout (about .02 roentgens to the fetus) may cause an increase of about 1% in the number of deaths from all types of cancer occurring in children in the 0 to 10 year age group."

This view is contradicted by Dr. Brues (Director of the Division in which Dr. Schubert is senior chemist), who states with regard to the British data, "It has been thought that these figures may apply to fallout radiation. I would very much doubt that it does, since the dose in diagnostic pelvimetry is given all at once, while that from fallout or the environment comes gradually over the whole life of the embryo." B.C.

CNI CALCULATION *(continued from p. 3 col. 1)*

child's growth. These figures are available from the medical literature. Using them, and knowing from the bone-curve, Fig. 1, curve (c), the strontium units expected in bone formed in different calendar years we can calculate the actual amount of Sr 90 added to the bone in each year of growth after a child's birth in 1958. Adding up all of these annual Sr 90 contributions and taking into account the fact that half of the Sr 90 disappears every 28 years, we reach the conclusion that a child born in St. Louis in the winter of 1958 and living in that area will have in his bones at maturity in 1983 a Sr level amounting to about 11 S.U. The amounts of radiation expected from these Sr 90 levels in the bone and their significance are discussed on p. 1 of this bulletin.

This calculation is of course theoretical and only actual measurements on bones and teeth (e.g. Baby Tooth Survey) will give us definite values and individual variations. J.M.F., E.R.

*) The estimate that the total diet levels of Sr 90 will vary in proportion to the milk levels may be in error as the other calcium-contributing foods may be drawn from a wider geographical area than is the milk and thus not differ as much from city to city. Measurements of the Sr 90 levels in St. Louis foods other than milk are not yet available. It is hoped that such information will be provided soon when the St. Louis County Department of Health begins its radiation surveys.

KULP STUDIES *(continued from p. 3 col. 2)*

Averages of this type do not really indicate the degree of danger to be expected from Sr 90 in bone. Some individuals may accumulate much more than the average, and some accumulate less. The Kulp group has attempted to learn something about these differences from their studies. They conclude tentatively that 10 per cent of the population will have twice as much Sr 90 as the average, one per cent will have 5 times the average, and nobody will have as much as 20 times the average. If this is correct, and if there is no further testing, it means that in 1966 10% of all one-year-old St. Louisans will have about 22 S.U., and one in every hundred will have about 55 units of Sr 90 in their bones.

Dr. Kulp's conclusion that no individuals will reach 20 times the average is based on his estimate that individual diets do not vary enough to cause such large differences in Sr 90 uptake. However he does not consider the fact that differences in individual physiological behavior, including diseases which affect calcium and strontium metabolism, may cause differences in Sr 90 absorption even where the diets are similar. There is therefore no reason to exclude the possibility that some rare individuals will have as much as 20 times the average amount of Sr 90 in their bones.

T.A.P., M.F.

FALLOUT RADIATION VS. NATURAL RADIATION

ONE WAY to estimate how much harm might result from radioactive materials that the body absorbs from fallout is to compare the body's exposure to fallout radiation with the exposure to the unavoidable radiation that the body receives from natural sources. The possibility that natural background radiation may be partly responsible for some birth defects and cases of cancer is being studied in several areas, such as N.Y. State and Maryland. First reports indicate, tentatively, that where local natural radiation is high, incidence of these diseases is also higher than average*. If such a relationship is substantiated, then radiation from fallout, if it becomes about as intense as background radiation, might be expected to increase the disease rate noticeably.

This matter was considered in the testimony of Mr. Merril Eisenbud of the AEC's N.Y. Operations Office. Citing data from his own office and from the report of the UN Committee on the Effects of Atomic Radiation** he concludes with respect to bone marrow that "The maximum foreseeable dose from Strontium 90 (Sr 90) in the New York area is thereby estimated to be about 5% of the dose due to natural radioactivity." This statement was widely quoted in the newspapers as evidence that at its peak radiation from fallout would add very slightly to the harmful effects of natural radiation.

Eisenbud conclusion doubted. On examination this conclusion appears to be incorrect. Our evaluation shows that in the New York Area radiation from Sr 90 will add 15-60% to the radiation that the bones and bone marrow receive from natural sources.

Two hazards need to be considered. One concerns the development of cancer in bone itself due to radiation exposure; the other concerns leukemia or blood cancer which may be caused by radiation passing into marrow cells that lie in tubes within the bone.

Bone hazard. The radiation hazard to the bone can be calculated as follows: According to the UN Committee's report bone cells receive from natural sources 130 millirem of radiation per year (p. 9 of report). According to this same report (p. 107) one unit of strontium 90 delivers to bone cells an average of 2.5 millirem per year. So, using Mr. Eisenbud's assumption of 5.5 Strontium units (S.U.) in the bone, Sr 90 delivers 5.5 x 2.5 or 13.8 millirem of radiation per year. This is 10% of the natural radiation (130 millirem/year), not 5% of it. Furthermore, bone with an *average* of 5.5 S.U. will have some parts with considerably more Sr 90. (For example, Dr. Schulert's testimony shows that some parts of a bone have 2.5 times the average Sr 90 content of the entire bone.) So, some parts of such bone will receive about 25% as much radiation as that delivered by natural sources. The maximum radiation is important because a cancer in the bone may be started by only one or a few cells which get enough radiation to start the disease process.

Marrow hazard. A similar result is obtained from our calculation of the Sr 90 radiation to the bone *marrow*. To compare the radiation from Sr 90 with natural radiation one must consider carefully a very important difference between the two kinds of radiation. According to the UN Committee's report most of the natural radiation received by the bone marrow comes from outside the body from cosmic rays and from radioactive rocks. This radiation has great penetrating power and passes through all parts of the body with an equal intensity so that its effects are evenly distributed throughout the bone marrow.

In contrast, Sr 90 is inside the body, being localized in the bone that surrounds the marrow. As a result those bone marrow cells that are most closely surrounded by bone (for example, cells that lie inside tiny pockets of bone) will receive much more radiation from Sr 90 than marrow cells which lie at a greater distance from the surrounding bone. For these reasons the UN Committee's report recommends (paragraph 65, p. 108) that consideration be given to the *maximum* bone marrow radiation rather than to the average. The report suggests that the radiation dose to the bone marrow cells most exposed to Sr 90 radiation will be between 2.5 and 10 millirem per year for each unit of Sr 90 present in the bone.

If we return now to Mr. Eisenbud's estimate of a maximum Sr 90 content in bone containing 5.5 S.U. we can see that this will deliver to some marrow cells (according to the UN Committee's report) between 2.5 x 5.5 (or 14) and 10 x 5.5 (or 55) millirem per year. If we now compare these radiation doses expected from Sr 90 to the radiation delivered to bone marrow by natural sources (95 millirem per year) we see that Sr 90 will raise the natural level of radiation by 15 – 60%.

Thus Mr. Eisenbud's estimate that in the New York area Sr 90 will add 5% to the radiation received by bone marrow from natural sources is too low. B. C.

*Studies showing a rate of birth defects 50% higher than average in parts of N.Y. State that have relatively high background radiation was reported by Dr. J.T. Gentry of the N.Y. Dept. of Health. A similar correlation between background radiation and cancer incidence in certain parts of Maryland is being studied by the U.S. Public Health Service (see Washington Post, May 16, 1959, p. A7).

**Report of the United Nations Committee on the Effects of Atomic Radiation, New York, 1958.

Baby Tooth Survey and the Hearings.

Dr. A.R. Schulert, whose laboratory is responsible for nearly all of the analyses of the Sr 90 content of bones, emphasized in his testimony the importance of data from children stating, "The young children are of chief interest, not only because they have the highest values but because they are probably more susceptible to radiation damage than adults. Highest concentrations at the present time are in the 1-2 year old group. These samples are very difficult to obtain." Of particular interest to St. Louisans is the fact that the St. Louis Baby Tooth Survey will produce extensive data on the amount of Sr 90 deposited in children's teeth during the first year of life – the exact period of greatest interest. The existence of the Baby Tooth Survey was not mentioned at the hearing.

NUCLEAR INFORMATION is published 10 times a year by the Greater St. Louis Citizens' COMMITTEE FOR NUCLEAR INFORMATION. Address: 4484 West Pine Blvd., St. Louis 8, Mo. Telephone: JEfferson 3-0353 (9 a.m. to 12 noon)

Subscription Rates: Individuals, one year $2; Organizations, (six copies per issue), one year $5.

The Committee for Nuclear Information is an organization devoted to the gathering and public distribution of facts about the effects of nuclear testing and the military and peaceful uses of nuclear energy.

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Hearings Reveal New Facts

• Radiation hazard of various isotopes in fallout.
UNTIL now most attention has been concentrated on Strontium 90 (Sr 90) and Carbon 14 but recent information reported by several experts at the hearing shows that other isotopes (Strontium 89, Cesium 137, Barium 140, Iodine 131) probably cause as much of a hazard as Sr 90. Dr. Carl Z. Morgan of the Oak Ridge National Laboratory stated that the allowable amounts of Sr 90 should be cut in half to take into account the radiation from other isotopes. Since most of these isotopes have rather short lifetimes, they are important only during a period of explosions and for a short time afterward.

Dr. A.R. Schulert reported that during the time when nuclear tests are underway and relatively large amounts of radioactive but short-lived strontium 89 is in a mother's diet, "The fetus may get considerably more radiation from Strontium 89 than from Sr 90 under such conditions. Thus this problem deserves more intensive investigation particularly in view of the fact that fetal life is more susceptible to radiation damage than post-embryonic life."

During the interval from June 1957 to April 1958 the average level of iodine 131 in St. Louis milk was 258 micromicrocuries per liter. The latest recommendation of the National Committee on Radiation Protection and Measurements is that the maximum permissible concentration of radioiodine in water (milk) for persons who are occupationally exposed to radioactivity is 20,000 μμc/1. The International Commission on Radiological Protection recommends that the MPC for the general population be obtained by dividing the occupational value by 30. This means that the population MPC for radioiodine is less than 700 μμc/1. For the 11 month interval mentioned above, (during which a considerable amount of bomb testing was done) the iodine 131 level in St. Louis milk was an appreciable fraction of the MPC. The MPC for iodine 131 is lower than that for any of the other short-lived fallout products. The reason for this is that iodine concentrates in the thyroid gland. Since the thyroid is small (25 to 30 grams in adults) this means that the radioactivity is concentrated in a relatively small volume and therefore the chances for cancer to be induced in the thyroid may be increased.

The MPC given above is presumably an average for all age groups. In testimony at the recent hearings, Dr. E. B. Lewis of the California Institute of Technology observed that iodine 131 in milk is a special hazard to infants and children. The reasons why it is a special hazard are 1) infants drink much more milk than adults and 2) the thyroid glands of infants are smaller and more sensitive to radiation than those of adults. Lewis estimates that of the 40,000,000 children in the United States now under 10 years of age, between 80 and 1600 might be expected to develop thyroid cancer during their lifetimes as a result of ingestion of radioactive Iodine 131 from fallout.

• Strontium 90 from non-milk sources.
Testimony at the hearings brought out the fact that vegetables and cereals will contribute an important part of the Sr 90 in our diet. Dr. Cyril Comar of Cornell stated that plant sources will account for about half the Sr 90, with milk supplying the other half. The importance of this new observation is that plant foods, especially cereals, contain much more Sr 90 than milk. For example, in 1957 when on the average U.S. milk contained about 6 S.U., wheat in Minnesota averaged 150 S.U. An AEC report at the hearings showed that bread purchased in New York City in February 1959 contained as much as 70 S.U. while flour contained between 30 and 600 S.U. For certain countries like Japan where most of the dietary calcium (and with it, the Sr 90) is obtained from cereals, this problem becomes quite severe. Very little systematic study of Sr 90 in the diet has been made as yet. An outstanding exception is the U.S. Public Health Service analysis of foods in Cincinnati. The analysis shows that milk products contribute 36% of the diet's Sr 90; vegetables 39%; cereals and pastries 15%; meats, eggs and seafood 5%; fruits and fruit juices 3%; other foods 2%.

• The "dirtiness" of recent nuclear tests.
An AEC report submitted to the hearings showed that tests by the USSR account for half the fallout on the earth and in the stratosphere; tests by the U.S. and Great Britain (mostly U.S.) account for the remaining half. The report also shows that both the U.S. and USSR tests in 1958 produced half of their explosive force in the form of fission, which is the source of fallout material. This means that the last tests by both the U.S. and the USSR were equally "dirty". The "dirtiest" bomb ever exploded (the 1954 bomb that showered fallout on the Lucky Dragon and the Marshall Islanders) was about 2/3 fission. A so-called "clean" bomb is supposed to about 4% fission. Thus, although according to a statement by AEC Commissioner Libby (New York Times, April 20, 1958) the 1958 tests were intended to develop a "clean" bomb with a 4% fission yield most of the bombs exploded were in fact "dirty".

• Concentration of fallout in the North Temperate Zone.
At the recent hearings all witnesses agreed that fallout was becoming heavily concentrated in the North Temperate Zone (which includes most of the U.S.), a region in which 80% of the world's population lives. This is particularly true of Russian nuclear explosions, for nuclear debris injected into the stratosphere in the Arctic comes down almost exclusively in the North Temperate Zone (see *Nuclear Information*, April 1959). This new fact appears to close an earlier controversy between the AEC (which maintained in 1957 that fallout would be evenly spread over the globe) and U.S. Weather Bureau scientists who predicted localized concentration.

• Upward revision of fallout estimates since 1957.
AEC data submitted to the recent hearings show that New York City had received a deposit of 56 millicuries of Sr 90 per square mile by the end of 1958; this value is expected to double before the maximum is reached, on the supposition of no further testing. Other data submitted to the hearings showed that in 1958 milk reached about 30 S.U. in North Dakota and 20.1 S.U. in St. Louis. As reported on p. 2 of this bulletin milk in the St. Louis area is expected to reach a peak of 34 S.U. in 1965.

These new estimates are considerably higher than estimates made at the first Congressional hearings on fallout in 1957. At that time, Dr. Libby submitted for the record a paper in which he predicted that the maximum fallout deposit would occur in 1970 at which time the earth would have an average of 7 millicuries of Sr 90 per square mile and there would be an average of about 8.4 S.U. in milk. Although tests after 1957 only doubled the amount of fallout injected into the stratosphere Dr. Libby's predictions fall short of the true values by a far greater amount. J.B.R., B.C.